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NOTICES OF The Aeronautical Society.

A Meeting of the Council was held on Feb. 24th, when the following gentlemen were elected Members of the Society:—

Mr. W. F. REID, C.E.

Mr. B. F. BROOKE SEWELL.

Capt. L. S. BLACKDEN, West India Regt.

B. BADEN-POWELL, CAPT.,
Hon. Sec.

The Possibility of Soaring in Horizontal Wind.

(Paper read before the Royal Society of New South Wales by L. HARGRAVE.)

There is a publication called the "Aeronautical Annual," edited by James Means, Boston, Mass. In No. 2 and 3 of that work, Mr. Octave Chanute goes exhaustively into the question of sailing flight, and specifies every letter and article that bears on the subject. This paper may be said to take up the running where Mr. Chanute leaves off. My reasons for not writing to that periodical straight, are that publication would be delayed for many months; and the state of the art is such that at any moment some one of the many who are investigating this subject may drop on the facts stated in this paper, take out a master patent which would rule the construction of all future flying machines, and tax us all round for our good, as the protectionists say, thus throwing our work back for years. I therefore, with your permission, read this paper, and show the models that work as I describe, and thereby destroy the novelty of the invention for all time.

The point of doubt has been, how to account for the phenomenon of soaring in a horizontal wind. There is no difficulty in soaring if we assume an upward trend in the wind such as a cliff, building, or sloping hill will produce. But when we see birds soaring in light wind and storm, something beyond our knowledge is recognised as being at work.

Mr. Chanute shows the profile of a number of soaring and non-soaring bird's wings, and points out the downward projecting lobe at the front edge of the former, and also that there is a sharp curve just abaft the lobe on the under side. (Figure 1.)

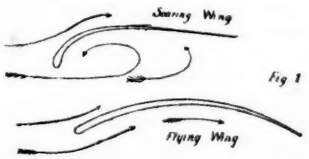


Fig 1

A few experiments have been made at Stanwell Park to show how this affects the effective direction of the wind when soaring, with the

result, as I previously surmised, that it was found to create a vortex, and that the direction of the air current beneath the wing was that indicated by the arrows in Figure 1.

The apparatus used was a small bellows, a bent piece of sheet aluminium and a candle. The centre of the vortex was found to be approximately at the centre of the curve of the fore part of the aluminium sheet. (Figure 2). The candle, you observe, is not masked by the leading edge.

Fig 2

The quasi-wing was then bent like Figure 3, and the candle flame was blown in a

Fig 3

manner showing that in this case the vortex was elliptic. The pressure at A must be greater than at C or the candle flame would blow parallel to the blast. As a first attempt to show that the pressure at A was greater than at B, I cut a small hole at B and gummed a tissue paper valve opening towards B. I could not be certain that air was passing through it.

A portable forge was now arranged to deliver air through a two-inch horizontal tin tube, and various devices were used for hanging things in front of the blast. Among others an old and rough gull's wing showed the loose feathers blowing towards the front edge. (Figure 4.)

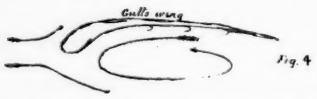


Fig. 4

When a piece of the wing was cut off and hung at eleven inches from the blast with a negative angle of about 28 degs., it at once began to revolve in an elliptic orbit, the feathers on the under side of the wing being ruffled back at positions A and B (Figure 5). When attempting to repeat this ex-

Fig 5

periment the wing could only be made to revolve in a contrary orbit to that shown in the figure. A piece of aluminium without a bulb would only swing very slightly in the line of blast.

A piece of tin folded with a bulb at the forward edge and some pieces of down gummed on the concave side, was set at a positive angle of about 6 degs., the down at the bulb blew strongly in the direction of the arrow (Fig. 6).

Fig 6.

Thirty-two three-quarter inch square holes were cut in a curved piece of aluminium (Figure 7), and each hole was fitted with a

Fig 7

tissue paper valve lifting on the curved side. When the chord of the curve was at about zero, A and B sets of valves lifted tangential to the leading edge, and C and D sets of valves were fluttering with the blast.

A level sheet of glass with a little water on it was placed in the line of blast, and the curved tin (Figure 6) standing in the water with a sprinkling of red ochre, shows the vortex at a negative angle of about 30 degs. The tin was set at zero, but the after edge was slued round to 30 degs. by the rotation of the vortex.

This is all very well as far as it goes, but something is wanted that would eliminate errors of direction of the wind, and some of the uncertainty as to the angles, and also to compare the curve with the plane surface. So I fixed a horizontal wire on a stand and pointed it towards the blast. A sleeve was on the wire revolving freely. On opposite sides of the sleeve I attached a bulb ended curved piece of aluminium and a piece approximately flat, with set screws to fix them at any angle with the direction of blast. There was a lead weight for balancing in the plane of rotation. There was nothing to stop the sleeve from slipping along the wire, which it did not do.

You will observe that with this apparatus if my personal equation gave any advantage to the curve it would be eliminated when the sleeve revolved 180 degs., and that both surfaces received a blast of equal intensity, and that placing the two surfaces on opposite sides of one axis is equivalent to weighing their respective lifting powers in a pair of scales.

The plane and chord of the curve were first set at a slight positive angle (Figure 8). In this case the curve easily rotated the sleeve against the lift of the plane. There might possibly be no vortex under the curve,

and the stronger rotating force might be due to the greater angle of slope of the after part of the curve.

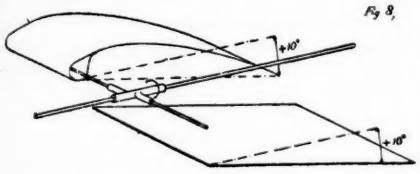


Fig 8.

The plane and the chord of the curve were next set parallel to the line of blast (Figure 9). In this case the lifting force opposed

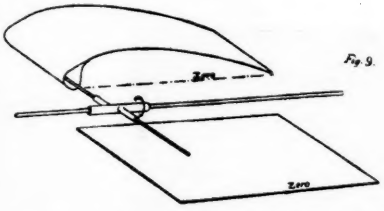


Fig 9.

by the plane to the curve was nothing, although its resistance was that due to its area and the velocity of the blast, and the lift of the vortex under the curve easily overcame this.

In Figure 10 the plane was left parallel

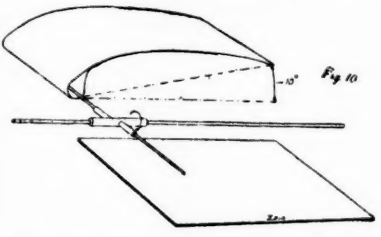


Fig 10

to the blast, and the curve sloped at a negative angle; this angle was increased to at least 10 degs., and the lift of the curve still

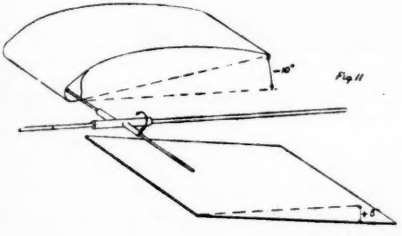


Fig 11

rotated the sleeve against the resistance of the plane.

In Figure 11 the plane was put at a positive angle of 6 degs., that is, 16 degs. between the plane and the curve. The plane was now able to rotate the curve against the vortex. Figs. 12, 13, 14, 15, show the stream lines of the air when it meets a curve set at various angles.

To recapitulate, the experiments show—

1. That the profile of a soaring bird's wing and pieces of metal of a somewhat similar curve generate vortices on the concave surfaces when the chord of the curves makes a negative angle with the direction of the wind.

2. All the concave surfaces are in contact with air moving towards the mean direction of the wind.

3. That the mean pressure on the concave surface is higher than on the convex side.

4. That the chord of the curved metal may make a negative angle of 10 deg. with the direction of the wind, and still have a higher pressure on the concave side than on the convex.

And the direct inference is that gravity can be entirely counteracted by a volume of disturbed air moving in a horizontal direction; and that flying machines of great weight can be held suspended in a horizontal wind, and rise vertically without the expenditure of any contained motor force.

Having put matters so that anyone can easily repeat my experiments and elaborate them to the last degree of precision, we now see why the best soaring is done in steady winds. The answer is, the bird is less liable to lose its vortices by a sudden gust and have to take a flap or two to balance itself on a fresh pair. The difference between flying and soaring is that the air in contact with the underside of the wing is moving towards the bird's head when soaring and towards the tail when flying. A soaring bird's wing is a shield dividing two currents of air moving in contrary directions. The vortex draws towards the shield and pushes it into the low pressure above the wing.

There is a very similar experiment described at pages 79, 80, of this Society's (R.S. of N.S.W.) Journal for 1893, but I then failed to see the true cause of the phenomenon, and thought the air currents were those shown in the flying wing (Figure 1), whereas the currents were those of the soaring wing.

Mr. Chanute says that "Dr. Thomas Young, the great physicist, showed in 1800 that a curve S-like surface suspended horizontally by a thread advanced against an air jet impinging upon its upper surface." If this S-like surface proves to be like Figure 16, and he explains the cause to be the vortex shown

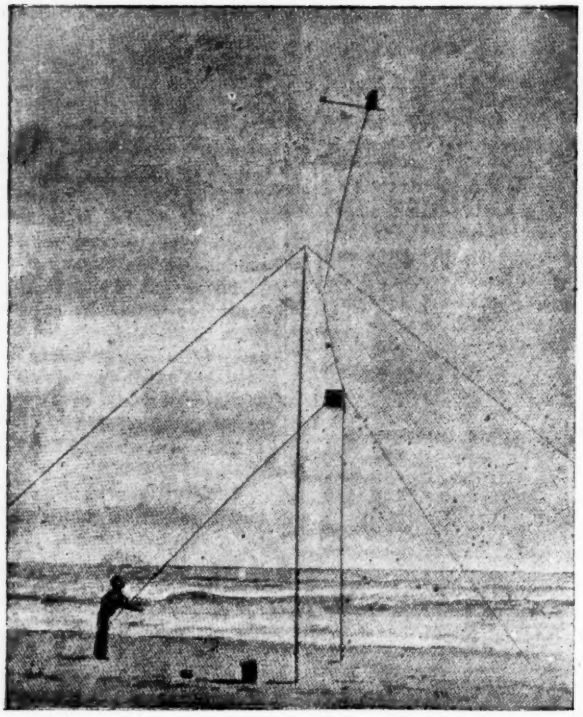
therein, it is only another proof that there is nothing new under the sun. The turn-up tail is now being experimented with, as I think

Fig 16

it provides automatic stability in a fore and aft direction.

Having experienced much of the monotonous process of repairing broken models, I have now devised and am using a method of experimenting that practically enables me to avoid all breakages. The apparatus used is well shown in the illustration which I think will advance the art of aerial navigation more than any amount of laboratory experiments. The two poles are twenty-four feet high and forty-eight feet apart. There is a cord between the tops of the poles, and the string of the soaring kite is tied to the middle of the cord at a sufficient height to prevent it striking the ground. I stand to leeward of the poles and start the soaring kite at a positive angle; it then flies as an ordinary kite to near the zenith. The vortex then forms under the curved aluminium surfaces and draws the apparatus at the full stretch of the string and cord, through the 180 degs. of arc to windward of the poles. The flag shows the wind to be horizontal, and the string that is plainly visible in the photograph shows the soaring kite pulling about 20 degs. to windward of the zenith. The wind was blowing at twelve or fourteen miles per hour, which was inadequate to effect the best pull the affair is capable of.

The projected area of the two curved surfaces is one hundred and eighty-nine square inches, and the weight is one pound four and a half ounces. The cylindrical aluminium tail is a serviceable construction. As yet I have been unable to make the kite stop when at or beyond the zenith, but the wind has been remarkably light for many weeks and few trials have taken place.



A very few trials will convince the most sceptical that if we are not soaring in moderate breezes before the end of the century it

will not be from ignorance of the way to do it.

It is obvious that soaring sails for marine propulsion have a vast future before them: and it is probable that craft so rigged will make better weather with a gale in their teeth than our best screw steamers.

*Kites: Their Theory and Practice.**

(By Captain B. F. S. BADEN-POWELL, Scots Guards.)

The Kite, one of the oldest of inventions, familiar to everyone and to every nation under the sun, is nevertheless but little understood. It has always been the custom to look upon this contrivance as a toy and nothing else. Very seldom indeed, until the last few years, has it been put to any practical use. Yet it is full of promise, and those few who have made regular and careful experiments in this line have all been impressed with the satisfactory results obtained. A kite sailing in a wind gives a very considerable pull on its line, which pull can be converted into lifting power or tractive power. This appliance may then be used for lifting great weights, such as that of a man, high into the air, or it may be used for towing carts or boats. Kites can be made to ascend to very great heights, carrying up automatically registering meteorological instruments, or may carry a string to communicate with places a long distance off. Why then, it may be asked, are they not more often made use of? I believe the sole reason is that so few men have devoted any time to studying the theory of their actions, and that when the well-known rule-of-thumb patterns are departed from, innumerable difficulties crop up, and the apparatus, for some inexplicable reason, becomes frequently unsatisfactory, so that a cursory investigation of the subject only opens up a vista of obstacles apparently almost impossible to surmount.

But with a little practice and study the way becomes somewhat clearer, and, as we grope along, fresh discoveries are made which raise our hopes and show what great results we may possibly attain.

* A paper read at the Society of Arts on March 2nd, 1898, Prof. W. Grylls Adams, F.R.S., in the chair.

I.—PRACTICAL EXPERIENCES.

Having devoted a considerable time to researches in this line, and with a view of throwing some light on the intricacies and difficulties to be met with in kite-flying, I will briefly relate my own personal experiences in this subject. To begin with, I had one definite object in view. For some time I had been interested in and had practically worked with captive balloons for military purposes, and finding the behaviour of them so erratic in strong winds, to say nothing of the difficulties of construction and inflation with gas, and of the cumbrousness of the necessary apparatus, I was looking about for some other means by which a man might be lifted to a height above the ground. Kites naturally soon suggested themselves, and on investigation I found that trials had actually been made on several occasions to lift a man by this means, but that these had invariably proved failures.

In 1887, I made several trials with small cambric kites. The largest of them was 10 ft. high, and had two cross-pieces about 4 ft. wide. This only lifted a weight of 2 lbs., which was attached to the tail. Many varieties of kites were tried. Some were of the ordinary diamond pattern, some had a bowed top; one was circular. I even got a kite to fly which was absolutely frameless. However, I came to no very definite conclusions, my experiments were knocked off, and I had no opportunity of continuing them for five years.

In 1892, I made trials with a 20 sq. ft. kite, from which I obtained two most important results. The first was that I found it possible to do away with that appendage known as a "tail," which I had hitherto presumed to be indispensable, and the second result was that by attaching a bag to the string some distance from the kite, I found I could put weights into it until the kite was able to lift a weight of 6 lbs. or more in a fairly strong, though not exceptional, breeze. This result, the lifting of ·3 lbs. per square foot of kite surface, was most encouraging, and convinced me that, under such circumstances, I should be able to lift a man with a kite of 500 square feet. I, therefore, determined to go to a suitable place and carry out a regular series of experiments for a week or two. I thus learnt many lessons, one of the principal being to appreciate the fickleness and variability of the wind. A kite which flew perfectly one day would scarcely rise on another. It would be impossible to give anything like a detailed account of my numerous experiments. I tried a great variety in forms of kites and attachments of string. I have records of twenty-seven different days' experi-

ments in that year, and many of them were devoted to very small details of construction. These experiments were continued the next year, but it really seems extraordinary how little actual progress resulted, so often did one particular idea have to be tried again and again under all conditions, before any decided conclusion could be arrived at; and as often as not did I finally conclude that that whole series of experiments was absolutely negative. Yet, again and again I had such successful days of work that I was encouraged to continue. Here are some of the designs with

I soon found that the wind force is always so variable from one moment to another that to record its velocity during experiments was hopeless, even though that may seem a necessity in careful scientific experimenting. I proved:—

1. That a tail is an unnecessary appendage to a properly constructed kite.

2. That by means of two strings suitably attached a kite can be guided so as to fly well some 45 degs. to each side of the wind course, and under favourable circumstances more.

3. That a kite which is perfectly flat, in very

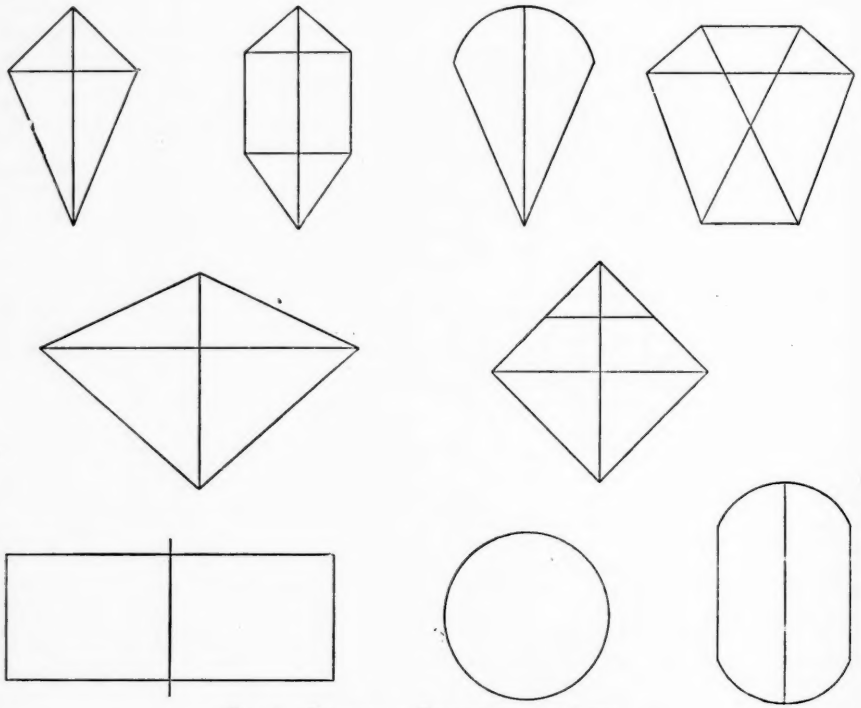


FIG. 1.—SHAPES OF EXPERIMENTAL KITES.

which, together with many others, I experimented (see Fig. 1). They all have certain advantageous qualities, but each required endless alterations before really satisfactory results were obtained.

These experiments have continued off and on up to the present, but, as I have said, it would be impossible for me to detail them all, though carefully recorded, I having up to date records of close upon 200 different days' experiments. I will therefore endeavour to summarise the results which I obtained.

light weather will fly well, but that in strong winds it will be very unsteady.

4. That if it be given much of a "diedral" angle, that is, if the sides of the kite are thrown back like a butterfly's wings, or if it presents a convex surface to the wind it will not rise to so great an elevation as if flat, but will be steadier in strong winds.

5. That a large kite flies more steadily than a small one.

6. That if the vertical section of a kite presents a concave curve from top to bottom

(thus ⌒) the kite will ascend to a certain height and then "top," that is, dive over forwards till it lies horizontally on the air, and will then sink to the ground. But that if the form of the kite is such that its section presents two or more curves (thus ⌒) this tendency is prevented.

7. That the angle which the string takes with the horizon is variable, depending on the form of the kite and on the strength and direction of the wind (which sometimes has an upward trend). The most usual forms vary from 30 degs. to 50 degs.

8. That the weight which a kite can lift will of course depend very greatly on the wind force, but a concave form of kite is more powerful than a convex one. In a light wind about ·1 lb. per sq. ft. of kite may be counted on, in medium winds ·3 lb., in strong ·5 lb.

9. That if the weight to be lifted be affixed to the kite, or very close to it, it is very liable to upset the equilibrium of the kite and render it unsteady.

10. That "duplex" lines, that is two retaining lines fixed apart on the ground, and attached to two points, one on each side of the central axis of the kite, enable it to fly with great steadiness in all winds.

11. That in light winds the line may be attached higher up on the kite than in strong winds, and that this raising of the point of attachment causes the kite to rise easier, but to be more unsteady.

12. That a "regulator," or line attached to the lower part of a kite, the pulling of which alters the angle it presents to the wind, causes it to rise or fall as desired.

13. That the pull of the string of a kite may be taken roughly as—in light winds ·1 lb per sq. ft., in moderate ·7 lb., in strong up to 2 lb. per sq. ft. of kite surface.

As for shapes, there are many kinds which fly well if properly adjusted. The following points have to be considered:—

1. *Lightness*, so as to ascend easily in light winds. For some purposes it may be desirable to construct special kites, but these very light ones should never be used in strong winds, else they might become strained or damaged. 2. *Stability* in strong winds, which quality may also necessitate heavy construction, rendering the kite useless in light airs. 3. *Portability.*—For most purposes, especially when large kites are desirable, it is necessary that they should be easily folded up. 4. *Simplicity.*—The more complicated forms of kites are very liable to damage, and one little detail going wrong may upset the balance and the whole efficiency of the kite. 5. *Power* to lift or draw. Some forms of kite possessing these qualities may not have so much power as others. Thus a baggy concave kite is powerful, though perhaps unsteady. 6. *Good Pise*, that is to say power of attaining a steep angle with its string. 7. *Strength*, both to withstand the pressure of wind and to stand knocking about while on the ground.

Though not absolutely necessary, a vertical backbone down the centre of the kite seems desirable. The crosspieces to hold out the material transversely may be in front or behind the cover, but what is better still is to have them enclosed in seams in the material.

A difficult question to decide is that of flexibility or rigidity. If the framework of a kite be very flexible, it may in strong winds so bend when struck by a strong squall that it lessens the effective area, and thus automatically regulates the pull on the line. This characteristic would appear to be most desirable. I have arranged kites with springs, so as to fold back diedrally when struck by unduly strong puffs; but practically I must own that so far I have not succeeded in devising any very satisfactory arrangement. The same may be said as regards springs applied to the bridle so as to allow the kite to automatically present a different angle to the wind, according as it is strong or light. In practice a stiff, rigid kite is generally the most satisfactory, even though the pull on the line may in consequence be as variable as the changes of wind force.

What I have hitherto found to be the best form all round, is one nearly hexagonal in outline, stretched on a framework consisting of three poles of equal length, one forming an upright "backbone," the other two placed across it at right angles to form "crosspieces." This form of kite is very simple and portable, as, when the backbone is unshipped, the kite (with its bridle) can be rolled up on the crosspieces. When flying, all the central square forms a powerful concavity, or rather two concavities divided diedrally by the backbone to give steadiness, while the top triangle prevents all tendency to "top." This pattern, for distinction, I have designated "levitor." As regards size, I find the most convenient to be 12 feet high and 12 feet wide. This is about the largest size that can be handled easily. The poles are as long as can be conveniently transported in one piece. Such kites weigh complete from 5 lbs. to 7 lbs. according as they are intended for light winds or strong, and have an area of about 110 square feet. I have about fourteen such kites. My largest kite

was 36 feet high, containing 500 square feet, but this, though I flew it on some twenty different occasions, I found to be rather unwieldy. I have one 24 feet high which is more convenient. I am still not quite decided whether it is practically best to use one or two large kites, or a number of small ones, for lifting weights such as a man. Small kites are handier—they are lighter for a given area (since very large kites necessitate very large poles), and if one becomes damaged it is more easily replaced, and if an accident occurs to one kite while flying in mid-air, there is not necessarily a sudden collapse of the whole apparatus. On the other hand, big kites are simpler to make, and require but one adjustment. They seem to float more steadily in gusty winds (since they are acted on by a number of variable currents), there is less complication of strings, and they are probably more efficient. I have frequently tried an appendage like the rudder of a ship, which has a decidedly steadying effect.

There is one form of kite which calls for special comment. It is known as the "Hargrave" or "box" kite, having been invented by Mr. Hargrave in Australia. I have here a specimen which will more readily convey an idea of its peculiar construction than a long description. You see it is like two boxes with their lids and bottoms knocked out and connected a short distance apart. This kind of kite has found great favour in America, where it has been used for many purposes, including the high ascents for meteorological purposes at the Blue Hill Observatory.

My own experience with such kites is rather limited, but in practice I have found them possess very little advantage over other good forms, and I am unable to comprehend any very special theoretical advantage in them.

Such a form of kite is bound to be heavy, and I will endeavour to show later on the theoretical objections to a heavy kite. The average weight of those used at the Blue Hill Observatory is about ·1 lb. per sq. ft. of sustaining surface. My "levitor" kites (which are of much larger size, and should therefore be heavier in proportion) averaging ·05 lb. per sq. ft. That is just half the weight for a given area. It is almost bound to be more complicated and difficult to fold up. Being heavier, I have always found a Hargrave more difficult to get up in light winds. In very strong winds, though the Hargrave may perhaps be steadier than any other single line kite, there is no comparing it for steadiness with one on a system of duplex lines. Still, for certain purposes, such as attaining great elevations in strong winds, it may be useful.

As regards retaining lines, I have generally used one of three systems: (1) the usual single line; (2) the "duplex," with the two lines fixed apart so that they join the kite at an angle of about 60 degs.; and (3) the "rein" or steering lines (for small kites), in which the duplex lines are held together in the hand, and used like reins for steering the kite.

The first system is employed if it is desirable to get out a great length of line, or for towing, and when steadiness is not a matter of importance; the second, when great steadiness is desired; and the third for steering kites.

In using several kites together, there are several different methods of attaching them, best explained by diagrams.

a. The "duplex" applied to several kites (difficult to apply more than two or three kite

b. "Parallel" system, each kite presenting the same angle as the one below it, and thus the whole system is under control.

c. Single line passing through the kites.

d. Single lines, each lower kite having a "back bridle."

e. Independent kites "buoying" the line.

Each of these systems is applicable under certain circumstances, and a combination of one or more is often used.

I have here a specimen of a kite fully fitted. By this system of running thimbles it can be used so as to fly independently on a single line, or duplex on two lines.

I also have a model to show what I believe is the best method of suspending the car to lift the man. In this he is perfectly steady. It cannot swing or rotate.

As regards materials, I have found that for the framework of all kites there is nothing like bamboo, though this material may be obtained in many different varieties, some not so suitable as others. I have tried various sorts of wood, but have always been dissatisfied with it. It is generally either too heavy or too brittle. Male bamboo, though very strong, is too heavy or too flexible. The same in an increased degree may be said of steel tubing. The thinnest steel I could obtain is very much heavier than bamboo of somewhat the same diameter, even though it may be stronger. If of much less diameter it does not possess the requisite rigidity. It is of course also much more expensive.

The cover I have usually made of light cambric, which is very satisfactory, seldom tearing unless through catching in some tree, etc. For very light kites I have tried silk, and also goldbeaters' skin. Paper is a wretched material, even for the roughest models. It is so liable to get torn even before an experiment can be completed with it.

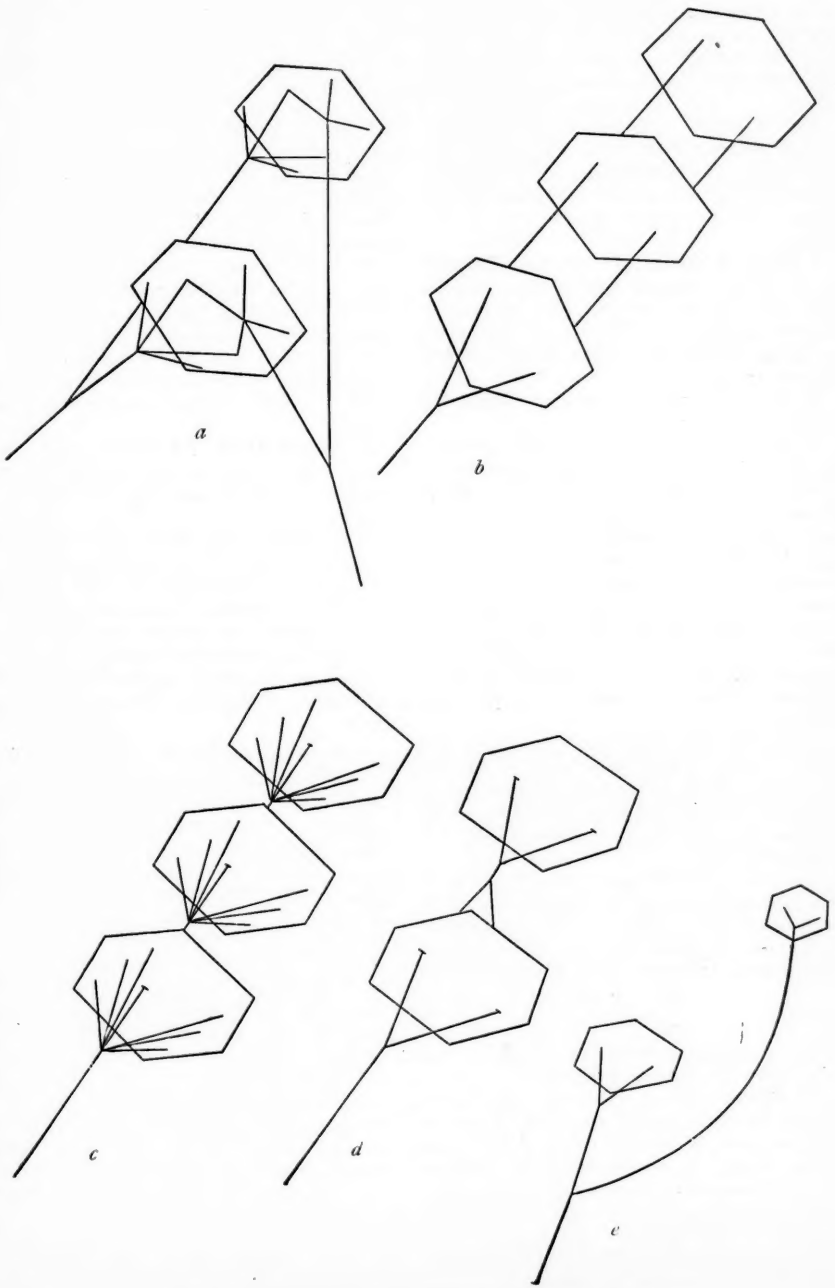


FIG. 2.—METHODS OF CONNECTING SEVERAL KITES.

For cordage I have generally used Italian or Russian hemp. Steel wire ought to possess great advantages; but in practice—at all events for experimental work—its liability to kink, to get rusty, to attract lightning, and its awkwardness to handle, render hemp preferable.

Let me add a word against all metal clip-hooks, spring swivels, etc., which I at first used much, but soon found to be unreliable, heavy, and generally unsatisfactory. Wooden toggles and eye-splices are much to be preferred.

I might emphasize the fact that these remarks on the materials used in kite construction are derived from my own experience. Careful experimenters in America have come to other conclusions. (Vide Marvin, Millet, Lamson, etc.)

I will now say a few words as regards the practical working of kites.

In very light winds there may be a difficulty in getting a kite up. Then it is best to lay out a long single line along the ground, say 200 or 300 yards long, let one end be attached to the kite, and a man hold the other end and run with it. The kite will thus rise up into the air some 300 or 400 feet, even though it be a dead calm. But often there is a light breeze above which is imperceptible below, and if the kite floats of itself its string may be affixed to a second kite, which it will gradually draw up, and thus a whole series carried up to the upper current.

Even very large kites may be got up in this way. I have several times tried towing such kites with about a dozen men running, or by attaching the kite line to a waggon drawn by horses. By both these methods a man has been lifted up.

The subject of the upper currents of the air has been discussed by Mr. Douglas Archibald, who conducted a series of kite experiments which tend to prove that the velocity always increases with altitude, and in the proportion of

$$\frac{V}{v} = \sqrt[4]{\frac{H}{h}}$$

when V and v represent the velocities, and H h the corresponding heights.

In strong winds it is usually best to use duplex lines, the ground end fixed to pegs or to trees, etc., so that the wind blows up between them. In strong winds the retaining line or lines should always be securely fixed before the kites are let up, else it may be impossible to hold them.

As far as practical utility goes, I have used kites for the following purposes:—

1. To lift a man similarly to a captive balloon, which may be very useful in military operations as well as for all purposes where a lofty look-out may be desirable. I have actually been lifted up on about eighteen different occasions, sometimes going as high as 100 feet (the limit of the perpendicular rope). I have also let up weights, equal to that of a man, 300 feet high; and I believe that the height attainable is chiefly dependent on the length of rope available. The kite area has varied from 300 to 800 square feet. In most cases I have used from three to eight kites, but have also made ascents with one kite of 500 square feet.

2. To lift a torpedo or large charge of explosive to be wafted over a fortification, etc., I have let up some hundreds of pounds weight and sent it off over a place half-a-mile off.

3. To take up a photographic camera so arranged as to obtain a photograph of the country beneath. I have here some specimens taken.

4. To sail boats, for which purpose kites seem most suitable as the boat can sail very close to the wind, and with no fear of capsizing.

5. To draw a cart, which may be very useful in open country. It is surprising the amount of power the kites possess even in a light wind.

6. Communication between ships at sea, by which letters and parcels can be conveyed without the necessity of lowering a boat.

Also for signalling, getting ropes to otherwise inacessible places, and many other purposes.

II.—THEORETICAL PRINCIPLES.

The theoretical principles of kite flying seems to have received but little attention from scientists. Professor C. F. Marvin, of Washington, has recently published two monographs, "Kite Experiments at the Weather Bureau," and "The Mechanics and Equilibrium of Kites," which practically constitute the entire literature (in English) on the subject, except for a few remarks in Mr. Chanute's interesting work, "Progress in Flying Machines," and in the "Aeronautical Annual, 1896," while the scientific researches of Professor S. P. Langley ("Aerodynamics") also throw great light on the subject.

In order to investigate the results of the forces acting on a kite we will assume that it is a flat plane, and that the wind blows in a steady, horizontal course. These conditions are practically but seldom met with, the kite surface usually forming a variety of curves and planes at various angles, while the wind is always variable both in force and direction.

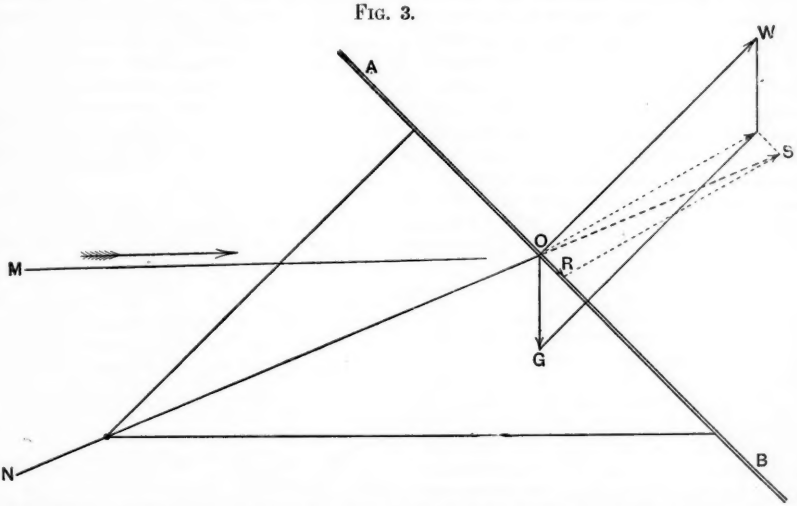
There are two forces acting on the kite in opposition to the retaining line—viz., the wind,

and the weight of the kite. The wind acts in several ways; it presses on the whole under-surface normally to the general plane of the kite; it acts on the front edges and on any projection tending to drive the kite in the direction of its central vertical axis; and it acts on the retaining line. There may also be a certain amount of "skin friction," though this is probably a very unimportant factor.*

In Fig. 3 let A B represent a vertical section of the kite; O W the wind pressure, which will be at right angles to the plane of the kite; the angle presented by the kite becomes smaller, while, on the other hand, the force of gravity or weight remains the same in intensity, but becomes more perpendicular. The frontal pressure, as a rule, increases slightly. Therefore, as the kite approaches the zenith, the total resultant becomes more at right angles. (Fig. 4.)

On starting the kite, the string will naturally be nearly horizontal, as M O. The direction of pull being O S, the kite will rise upward, until the string comes in the position, O N.

FIG. 3.



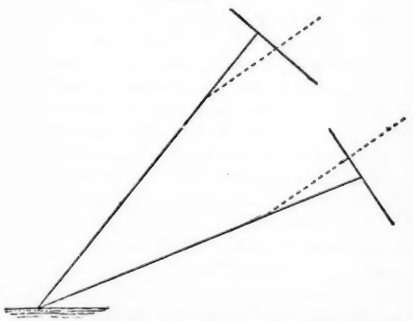
O G represents gravity, or the weight of the apparatus; O R the "frontal pressure," that is, the edge resistance of the kite and cords and all projections to the wind. Then, by completing the parallelogram, we get O S for the total resultant, which gives the force and direction which the string has to oppose in order that the kite shall remain in equilibrium.

From this figure it will readily be apparent how important are the proportionate relations of weight and frontal pressure to the effective wind force, in that, as the latter (O W) increases, the total resultant, or direction of pull, becomes more and more perpendicular to the kite. Hence, with a heavy kite in a very light wind, the string will pull at such an angle that the kite cannot rise to any great height.

As the kite rises in the air, pivoted about the base of the string, the direction of the wind force remains the same—that is, normal to the surface—but it lessens in intensity as it rises above this, it will, of course, be blown back to the position O N.

Hitherto we have taken the point O as the centre of effort of the wind. But in practice this exact point is not easy to find. Moreover,

FIG 4.



as will presently be shown, it shifts about accordingly to the angle of the plane. To overcome this practical difficulty a "bridle" is used. This consists of strings fixed on the

* "The friction of the air is inappreciable. This fact may be stated as the result of my own experiments, and of well-known experiments of others."—Prof. Langley's "Aerodynamics."

kite at points above and below the place of the centre of effort, and connected together in the ground line. The use of the bridle, then, is to automatically adjust the direction to the pull of the string towards the centre of effort.

The action of this contrivance can be more easily understood if we suspend a rod horizontally by a piece of string fixed to its centre. If a weight be hooked on to the rod on one side of its centre, it at once tips up. The same occurs with a kite in which the string is affixed to one point—directly the wind force is greater on one side than the other the kite must tip up. But now if we put a bridle on the rod, i.e., suspend it by two strings fixed apart on the stick, and held together above it, a weight can be hooked on to any point between the strings without the rod tipping up to any great extent. Under such circumstances the rod will be inclined until the weight (or rather the centre of gravity of the whole) hangs just below the point of suspension. In the kite this means that such an angle will be presented to the wind that the pull of the string will point towards the centre of pressure.

With a plane surface placed at right angles to a current of wind, the centre of the figure will be the centre of effort, and it would be comparatively easy thus to determine the exact centre of effort of any given kite were it not for a law of nature only recently determined, which is, that as a plane presents a less angle to a fluid impinging upon its surface, the centre of pressure moves forward towards the front edge of that plane. Therefore, as a kite rises in the air the angle it presents to the wind becomes less, and therefore the centre of pressure shifts forward.

The experiments of Langley, Joessel, and Kummer practically agree in showing that the centre of effort works forward of the centre of area according to the formula—

$$d = (0{\cdot}3 - 0{\cdot}3 \sin \alpha) L.$$

L being the length of a square plane, which may, of course, give a slightly different result to the ordinary shape of a kite.

I have already referred to the "diedral" angle of a kite giving stability. The reason for this is easily demonstrated.

A B C (Fig. 6) represents a horizontal section of a kite having a considerable diedral angle. The arrows show the direction of the wind force against the two sides. Now, in strong winds many twirls and eddies are found in the wind currents, just as one sees them in a rapid-flowing river. Such eddies cause uneven pressures to be produced on different parts of a kite. If then a greater pressure is suddenly brought to bear on the side A B, this side is driven back, and a smaller angle is presented to the wind; while the other side, B C, is pressed forward, and, by becoming more at right angles to the direction of the wind, takes a greater pressure, and thus equilibrium is automatically restored.

It has been pointed out that this form of kite has less tendency to rise high; the reason of this, too, is explicable. The bending back of the sides, of course, diminishes the effective area of the kite—that is, wind-pressure is diminished; but the weight and frontal-pressure remain the same. Hence the resultant pressure acts less perpendicularly.

FIG. 5.

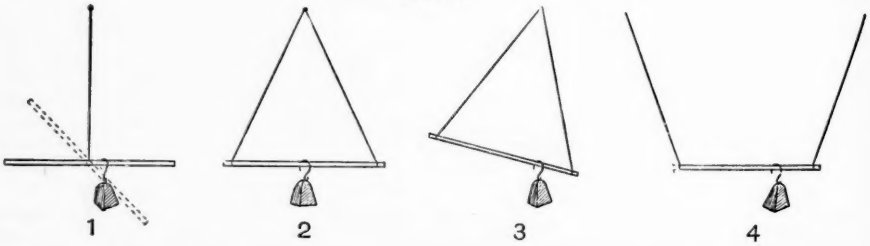
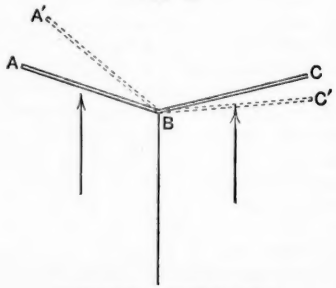


FIG 6.



CURVED SURFACES.

We began by assuming that the kite was a flat plane, which it seldom is in practice. The

action, however, of a current of air impinging on a curved surface is one very little understood. I think we can explain the action of a kite whose whole vertical section consists of one concave curve, and which, as I have said, in practice is always inclined to "top" over into the wind. On the principles already explained, we can understand how the pressures towards the upper portion of the curve, where the surface presents a small angle to the wind, are advanced forward, and that the result will be a strong upward pressure. When the kite has risen to a given height, the angle presented by the front portion of the curve will have become less and less, owing to the direction of the pull of the string, until it is absolutely horizontal, and then not only is there no pressure on the front part of the kite, but the wind will pass over the top, and cause the flexible material to shiver and bag, so that all buoyancy is lost, and it then naturally rolls over and spills out its wind.

DUPLEX LINES.

The theoretical advantages of "duplex" lines can be explained in the same manner as those of the bridle. If a horizontal section of the kite be taken it will be like the rod suspended by a string from the centre. If the wind pressure comes on one side the stick or crosspiece of the kite is tilted over. This will at once cause the whole kite to be driven away to one side, and thus in a variable wind the kite will be continually moving from side to side. Directly, however, we suspend the rod by two strings it is apparent that no shifting of the weight or pressure can cause it to move (see Fig. 5, No. 4).

TAIL.

It may be as well to inquire into the *raison d'etre* of the tail. It is not likely to have been applied to kites all these years without some reason. Now we know that a badly-constructed kite is liable to turn over and dive to the ground, or swing from side to side. How can this be prevented? If the lower end can be kept down and back the kite cannot capsize. If a heavy weight were attached to the bottom of the kite any irregular movement would set it swinging like a pendulum, and this action would probably be increased until the kite revolved right round. Moreover, the weight would simply tend to pull the kite straight downwards towards the ground. On the other hand if a long light tail were attached, so as to be driven back by the wind, it would have a tendency to pull the kite flat. By contriving the two, judiciously adding weight to a long tail, the desired result may be obtained of rectifying the faults of a badly-constructed kite.

It is often difficult to get practice to agree with theory. Thus, for instance, according to theory, if the wind is blowing at about 50 miles an hour, the pressure on a plane surface at right angles to it should be at the rate of 12 lbs. per square foot. Thus on 100 square feet it should be 1,200 lbs. But if the angle be inclined, even to 30 degs. with the horizon, the normal should be .8 of this, that is, 960 lbs. Practically, however, though I have had out kites to test their pull during strong gales, I have no record of a 100 ft. kite ever pulling more than 250 lbs. on the string, and this amount is quite exceptional.

When considering what weight can be lifted by a kite, and to what height it can be raised, the forces acting on the string must be considered. These forces are the weight of the line and the pressure of the wind upon it. These cause the line to hang in a curve, more horizontal near the ground and more perpendicular near the kite. The total force thus acting tangent to the string (commonly called the "pull") may be divided into two forces of "lift" and "drift," that is, a force acting vertically upward and one acting horizontally in the direction of the wind. Now it can readily be understood that the "lift" is greater in proportion near the kite than near the ground, while the "drift" may become so great near the ground as to pull the line horizontally, and not even lift it off the ground. But on comparatively short lines and in a good wind this curve is not of importance. We have, however, to consider the effect of hanging a heavy weight on the line. That portion above the weight will remain at the angle caused by the pull of the kite. But the angle of the string below can be readily found.

DISCUSSION.

The Chairman said the experiments of Captain Powell established a good many facts which had an important bearing on this interesting subject, and the explanations he had given were very clear. He had had the privilege of seeing and taking part in some of the experiments carried out last week at Hounslow, and seeing how the kites actually performed. As was shown in one of the slides, the kites were sometimes rather unsteady, and swayed about; the fact was that the wind was very variable indeed, and although at the surface of the ground it might seem to be steady, yet when tested by these kites a little way up, it did not remain steady many minutes together. Some of the principles which had been estab-

lished by Captain Powell, as, for instance, the application of two strings to keep the kite steady and guide it, and make it fly even at an angle to the wind, were very important in practice. A kite which would only fly in the direction of the wind would be of comparatively little service, because it seldom happened that the wind blew exactly in the required direction. He was hardly prepared to find that so much had been already accomplished, and was very glad that the subject of aeronautics had advanced so far within the last three or four years. Kites would be useful, not only for military purposes but also to travellers, and he had no doubt that if Nansen had had kites which were easy of manipulation he would have been able much more readily to overcome some of the difficulties he met with in his Arctic expedition. In connection with sledging he should think they would be of great use, and would be available where balloons were out of the question. An international conference on the subject of aeronautics was shortly to be held at Strassburg, when the use of balloons and kites would be discussed, chiefly in connection with meteorology, with the view of selecting a number of stations where observations might be made simultaneously on the physical phenomena of the atmosphere over a large area.

Mr. R. H. Scott, F.R.S., said a special committee had been appointed at the Meteorological Conference in Paris in 1896 to study the question of simultaneous balloon ascents for the purpose of making observations, some carrying human observers, and others only instruments, and, on three occasions, balloons had been started at the same time from Paris, Strassburg, Berlin, Munich, and in one or two cases from St. Petersburg, in order as it were to take soundings of the atmosphere on the same day at different points. He had received notice of a meeting of this committee, which was to be held at the end of the month, from Dr. Hergesell, the head of the Meteorological Institute at Strassburg, chairman of the committee, and also signed by the well-known name of Monsieur de Fonvielle. He saw that one particular section of the programme was devoted to the use of kites, for which Mr. Rotch was going to furnish an account of his experiences at Blue Hill. The committee would deal particularly with a form of apparatus, the kite-balloon, of which he believed the inventor was present. He understood that an ascent was to be made with one of these kite-balloons during the conference. He should be glad to receive papers from any one who had anything to communicate to the conference, and, if sufficient notice were given him, to procure invitations. They were much indebted to Captain Baden-Powell for the trouble he had taken in preparing the paper.

Mr. Douglas Archibald said he had been much interested in hearing the experience of Captain Powell, which seemed to bear out practically results which Professor Marvin had deduced theoretically, as stated in his recent work, and he must say that in these matters he preferred the deductive to the inductive method. He considered Professor Marvin's work on kites was perhaps the best handbook on the subject, and he had done good service in working out the theory so fully. Captain Powell had dealt more with the kites themselves than their applications, on which subject he thought there was room for another paper. There was an immense field open in that direction, for this was a science which had been too long neglected. Until he first resuscitated kite flying in 1883 it had been buried in oblivion since 1847. He had recently tried to interest the War Office, but was told that the military authorities did not think it necessary to experiment any further. He was sorry to hear that, because he thought if the experiments had been carried a little further, in all probability some very practical results would have been attained. In the recent Tirah campaign a few kites with cameras attached to them, would have been of very great use, and might have given information as to what was going on at the other side of some of those very steep and inaccessible hills. He had lately been thinking out one or two forms of apparatus by which this could be accomplished, and was confident that it would be quite possible. Some people might have doubts about it, but, at any rate, there could be no harm in trying. The Hargrave kite exhibited was not quite as it was described by the inventor. He met Mr. Hargrave in Australia, and spent an afternoon with him in flying his kite. The front and back were fastened together with wires or bamboos, and there were also cross struts, so that the whole thing was rigid. It was probable that Captain Powell's kites were lighter, but he thought some form of the Hargrave was the most satisfactory, especially in a heavy breeze, but he had not seen Captain Powell's in action, and could not therefore judge of their relative merits. He agreed that bamboo was by far the best material to use. People often said, how could you get up a kite when there was no wind? but that was a pure assumption; we were at the bottom of an aerial ocean, and very few knew what was going on above. Some years ago—in 1883, 1884, and 1885—he made a great many experiments, and

he remembered that frequently his kites were up in the air pulling tremendously when he could have lit a match without the slightest flickering where he was standing. That usually occurred at night, and it had been shown by Professor Marvin and others that night was the best time for flying kites, though it might not be the most convenient. During the day the air was more disturbed. There was a question of the apparent discrepancy between observation and theory with regard to the pressure and lifting power which ought to be cleared up. He believed it arose in great measure from continuing to use an old formula, which had been shown to be erroneous, the co-efficient being really ·0026 instead of ·005. The whole subject was one which required working at rather than talking about, and he should like to see more people paying attention to it, and applying it in various ways. It was already used for photography, and he had heard recently from naval officers that it would be very useful for communication between ships at sea. For scientific purposes generally, it would no doubt come into use for ascertaining pressures and temperatures at great heights. In America he saw they were planning a series of kites at high levels, so as to form isobaric charts at an elevation of 5,000 feet, which seemed rather a bold idea. When he was at Blue Hill, on one occasion he superintended the kite flying, when they elevated a barograph to a height of 7,300 feet, and after he left they reached as high as 9,000 feet. When they could carry recording instruments to heights like that, it seemed to him they were running balloons rather hard. Captain Powell said he was not certain whether it was more advantageous to use large kites, or small, and he agreed that it was a matter on which you had to compromise. A large kite was more useful and convenient, but small ones were more portable. Mr. Hargrave once said that he thought a man with five of his kites under his arm could ascend from the top of an omnibus. It would be rather an uncomfortable place to start from, probably; but his idea was to show the degree of portability possible. He was rather in favour of large kites himself, as they flew better; but, if for other reasons it was desirable to have several smaller ones, it was best to have, say, three at the top and one or two below. It had been shown by theory, and he believed it would be found true in practice, that the best arrangement for kites tandem was to have a bunch at the top, and then the others seriatim below. The greatest pull was obtained where you got the greatest velocity, and the total lifting power was greater with such an arrangement. Since he invented the kite-balloon some years ago he had not touched the subject at all, but when in Germany last year, he heard that a kite-balloon of some form had been adopted by someone, and hoped it would prove successful. He could not help thinking that the idea had something in it. A balloon rose in a calm, and a kite rose in a wind, and when you had something between a wind and a calm, a combination of the two seemed to be the right thing. When the wind dropped, the balloon kept the kite up, and when the wind rose the kite had a tendency to keep the balloon up. His plan was to have a balloon with a kite fastened in front of it in such a way that the kite shielded the balloon from the effect of the wind. In fact, the late Mr. Charles Spencer once told him that he thought of it as a balloon shield. The balloon must not rise much above the kite, otherwise the wind, being horizontal, would have a tendency to pull the balloon away from the kite, so that the balloon must be rather smaller in section. The fastening was effected by means of straps from the top of the balloon. It was described and figured in *Nature* in 1884.

Colonel Allan Cunningham said it was rather curious that the toys of a thousand years ago should be now utilised for military purposes, but it was not quite correct to say that kites were only now being used for the purpose of traction, because he had read of their being used to draw carriages and boats long ago. The modern use of the war balloon also, he believed, proceeded from a toy. The combination of the two was very interesting, because the captive balloon was at its best in calm weather, and it was very difficult, and indeed dangerous, to use in a high wind, whereas a kite was difficult to use in a light wind, and was at its best in a strong wind. In these kites they saw a very pretty adaptation of means to ends—the shape of the kite, the shape and the disposition of the frame, and the combination of cords. One of the greatest advances seemed to be in the adoption of a number of cords, which secured that great desideratum, steadiness. He had seen them flying, and those which were high up were very steady, and even those low down, probably in consequence of these attachments, were fairly steady also. On the other hand, the number of cords introduced certain practical difficulties, each point of attachment being a source of weakness, and on each occasion when he had seen a public exhibition something gave way, either a cord or its attachment, and the kite got out of its proper position. If there was a man up in a car this might be dangerous. The exhibition to which he referred was at Ipswich,

and there was a very large crowd present, which probably was not favourable to success The kite-balloon was also very interesting, but he must confess it was rather ugly to look at, and a balloon being such a delicate object, he always had a fear that it might be injured if anything gave way in the framework of the kite.

Mr. W. F. Reid said he happened to be present at Ipswich when the kites went up, and though there was a little hitch at the beginning, he thought it was due to the pressure of the crowd, which led to the rope being pulled at the wrong moment. The defect was soon remedied, however, and they went up all right. He had the pleasure of going up about 100 feet in the basket. He thought the portability of the apparatus had hardly been sufficiently dwelt upon. On the occasion in question, he saw the whole thing being taken into the park on a costermonger's barrow. This was a matter of great importance for military purposes, and he agreed with Mr. Archibald in thinking it was a great pity that some of these kites were not available in the war on the Indian frontier. One mule would have been quite sufficient to carry everything necessary to enable our brave soldiers to see what the enemy was doing. The system of double lines which gave the power of altering the angle and adapting the position of the kites to the strength of the wind was of the greatest importance. The tail, which had constantly to be added to or shortened, was always a nuisance, and it was a great thing to get rid of it altogether. With regard to the lifting power not being so great as they would require, he found when experimenting some years ago that by making a hole in the centre of the kite you actually gained power or pull. He found that if he made a centre hole and fastened the sides with india-rubber, which adapted itself to the strength of the wind to some extent, he got very favourable results. Another application which had not been mentioned was the saving of life at sea. A kite would occupy very little space, and if the sailors were properly drilled so as to use it, many a valuable life would be saved when a ship got on the rocks near shore. These things were all helping forward the time when we should be able to navigate the air. Practically a kite of this description was an aeroplane, and if a motor were substituted for the string, you would be independent of the ground. All the information gained in these researches would be of great value hereafter, and would bring us more rapidly to the goal of aerial navigation.

The Chairman said he was not at all surprised at Mr. Reid's statements that making a hole in the kite improved it, and it was satisfactory to think that if kites were used for warlike purposes, and the enemy's shot made holes in them they would fly all the better.

Captain Baden-Powell, in reply, said they were indebted to Mr. Maclure for the loan of the photographs, which had been shown, which were taken specially for his magazine. He had never seen Mr. Archibald's kite-balloon, but, theoretically it seemed to him that a kite and balloon combined had the disadvantages of both. If it were calm, the balloon would go better without the kite, and if it were windy the kite would go better without the balloon. He also, as honorary secretary of the Aeronautical Society, had received some papers relative to the conference at Strassburg, and should be glad to furnish any information with regard to it. He agreed that Mr. Marvin's pamphlet was a valuable contribution to the literature of this subject, but his bigger book went almost too deeply into theory, and arrived at some conclusions which were hardly warranted by experience. His experiments were almost confined to Hargrave kites, and a few of the Eddy shape. He recently had a letter from an officer on the Indian frontier, in which he said he wished he had some kites out there, and this was rather interesting after the remarks which had been made. He had stated that the model shown was not a real Hargrave kite: he only brought it to show the general idea. As to the crowd at Ipswich, he was glad to see that the public were so much interested in the matter, but must confess that he had the greatest difficulty in getting the people to leave the things alone, they were all so anxious to render assistance where it was not wanted. The result was he had several mishaps. There was some suggestion about danger in coming down, but he always had a parachute fixed above the car, so that in case of the cords breaking, it would come down gently.

Mr. Spencer asked if the fabric of the kite could not be so framed as to act as a parachute.

Captain Baden-Powell said that the idea had often occurred to him, and he had tried to arrange it, but was always met with this difficulty, that in order to make a satisfactory start it was necessary to have the weight to be lifted a long way from the kite; the kite ought to be about 100 feet up before it would do any useful work in lifting, and it would introduce great complication to work a parachute at that distance. He hoped many people would take up this subject and work at it; it was not only useful, but formed a very interesting amuse-

ment. He had even heard it said that it was better than golf.

The Chairman then proposed a cordial vote of thanks to Captain Baden-Powell, which was carried unanimously, and the meeting adjourned.

Twenty-four Hours in a Balloon.

A full account has recently been published * of one of the longest balloon voyages ever undertaken. (In point of duration it has been beaten at least once.) The ascent was made on October 19th last, at Leipzig, in the great balloon belonging to MM. L. Godard and E. Surcouf, which had been used for captive work throughout the summer at that place. At the close of the Exhibition it was decided to let the balloon go free. It was therefore specially fitted for the event, the large annular car being replaced by a smaller rectangular one. A novel feature was an "equilibriator" or guide rope of steel wire with a leaden core. This was 11 mm. in diameter, 50 metres long, weighing 25 kilogs, and was attached to the end of a hempen rope 100 metres long and 25 mm. diameter. A guide-rope of cocoa fibre, 80 metres long and 40 mm. diameter, was also taken, as well as the anchor cable, which had a breaking strain of 10,000 kilogs. (22,000 lbs.). An electric lamp was taken, also two barometers, two thermometers, a hydrometer, and other instruments. The weights were as follow:—

Balloon and equipment	2,849 lbs.
Eight people	1,331
Ballast, 49 bags of 55 lbs.	2,695
Printed papers, 10 packets of 55 lbs.	550
Personal baggage	176
Food and water (four meals)... ...	176
	7,777 lbs.

The gas, in spite of having been six months in the balloon, still had a lifting force of 69 lbs. per 1,000 cubic ft.

The balloon was in charge of M. L. Godard, with M. E. Taupin as assistant, and the following gentlemen who ascended: R. Meischke, O. Duncker, W. Paul, Prof. M. Krausé, M. Halfter, and R. Lencer.

At 5.15 p.m. the order to let go was given, and the balloon rose to a height of about 1,000 ft., and passed over the town of Leipzig. A light W.S.W. breeze was blowing about twenty miles an hour.

For the first two hours nothing special is recorded. At seven o'clock, when at 1,800 ft., dinner was served, and the aeronauts apparently did themselves well on cold partridge, champagne, &c. At 9 o'clock the speed was sensibly increasing, and lightning was noticed. At ten o'clock, the voyagers were between Berlin and Frankfurt, the lightning was flashing on both sides of them and peals of thunder were heard, but as they counted 30 seconds between the flashes and the claps they feared no danger. By half-past ten it was raining in torrents, and 300 lbs. of ballast had to be discharged to compensate for the weight of water on the balloon. The altitude was now only 500 ft, the storm increased in violence, and the lightning came closer. The speed of travel was now calculated to be 70 kilometres (43 miles) an hour. The aeronauts appear to have been having anything but a pleasant time. For two and a-half hours they were in the midst of a thunderstorm, "tired and very sad." By half-past twelve the lightning became less frequent, but the rain continued, and towards two o'clock they concluded that two hours more would carry them over the Baltic Sea. During the storm, 1,200 lbs. of ballast had been discharged, and the question was now put whether to make a descent or to continue the journey. M. Godard, after inspecting the ballast, declared he could remain another ten hours in the air, and as the Baltic was not more than 400 kilometres across, and that distance could be passed over in about six hours, it was decided to continue.

The balloon was now 1,200 metres up. But the spirits of its occupants required a little raising with champagne and cognac. The course of the balloon had now changed slightly more to the eastward, to the right of Königsberg At 5.30 the day dawned. There was a thick fog, though the guide ropes were on the ground, and the rain beating in under the balloon wetted its occupants, who had hitherto remained fairly protected by a collar round the balloon. A considerable speed was still being maintained, and the car swept into some fir trees, but by throwing out three bags of ballast an altitude of 4,000 ft. was soon after attained.

Towards nine o'clock a descent was made in order to determine the direction of the course. The end of the guide rope just

* *Ballon Captif de Leipzig.* L. Godard. Paris: L. Lambert.

trailed on the ground, and it was now found that the wind must be from the north. The country was well cultivated, and from the costumes of the peasants it was surmised that the voyagers were in Russia. The aeronauts were for some time unable to ascertain from the people their whereabouts until they recognised the name "Grodno." The speed was now 80 kilometres (49 miles) an hour, and the direction of the wind changed to E.N.E. At 10.30 more rain came on, and the ground was lost sight of. Several layers of clouds were passed through, and an elevation of 1,900 metres attained. A great dejeûner was partaken of at 11.15. Less than one-third of the ballast taken now remained, but a steady ascent was made as the sun shone out. At 2.20 a height of 3,240 metres (10,500 ft.) was reached, the maximum altitude of the journey; blue sky, thermometer 4 deg. C., and an immense carpet of cloud beneath, forming a grand spectacle. Soon after the balloon descended again into the clouds, and arrangements were begun to prepare for landing. The frontier of Russia was again crossed, and it seemed as though the balloon was making for home again. Rain commenced again whenever the voyagers approached the earth, but at 4.15, after a final toast had been drunk, all arranged themselves for the descent. Again the wind changed, and the balloon took a more southerly and then easterly course, passing just to the east of Breslau. At five o'clock both guide ropes were trailing. Several trees were "cut down" (*fauchés*) by the steel guide rope, which several times stopped the balloon, and the hemp rope, which united it to the car and which had a breaking strain of 3,850 kilos., broke. What remained of the guide ropes travelled well, but the balloon was progressing at a great speed—115 to 125 kilom. Only nine bags of ballast (225 kilogs.) remained. The balloon was passing over a large wood, and the car brushed the tree tops. As the edge of the wood was approached, Godard let go the anchor, and opened the valve. The balloon dragged on for a short distance, and then quietly collapsed, and a most satisfactory landing made. It was exactly 5.38, so that the journey had lasted just 24 hours 15 minutes. The descent was made within 600 metres of the village of Tarnau, Silesia. The distance travelled is estimated at 1,665 kilometres (1,032 miles).

NOTES.

INTERNATIONAL COMMISSION FOR THE EXPLORATION OF THE HIGH ATMOSPHERE.—This Conference assembled on March 31st, at Strassburg, under the presidency of Dr. Hergesell. Reports of former ascents were to be described, and details of the methods of registration gone into. Balloon and kite ascents were also to be made. It is unfortunate that no English representative was able to attend. Mr. A. L. Rotch, of Blue Hill, represented America; M. de Fonvielle, and others, France We shall look forward with interest to the results of this Conference.

FROM LONDON TO FRANCE BY BALLOON.—Messrs. P. Spencer and George Griffith ascended on February 8th from the Crystal Palace, at 11.20 a.m. The Channel was reached, in the neighbourhood of Dungeness, at a quarter to one, the elevation then being 5,500 feet. The thirty miles to Boulogne took about an hour, the balloon passing directly over the harbour at a height of 6,000 feet. A steady rise took place over the land until 10,000 feet was attained. At about 3.20 a descent was made at Verchin, close to the field of Agincourt.

THE PARIS EXPOSITION OF 1900.—The following gentlemen have been appointed members of the Committee of Administration of Aerostation:—MM. Bouttiaux, Commanding 1st Co. of Aerostiers; Espitallier, Commanding Battalion of Engineers; W. de Fonvielle; Eugene Godard, Aeronaut; Henri Hervé, Aeronaut; J. Joubert, Meteorologist; Krebs, Major, Sapeurs Pompiers; Lachambre, Aeronaut; Lauriol, Engineer; Renard, Commanding Battalion Engineers; Sarran, Professor; Serpette, Naval Captain (late Commandant of Naval Aerostation Park); Tissandier, Aeronaut.

ARMY ESTIMATES, 1898-99.—The amounts to be appropriated to military ballooning this year are:—Instructor in ballooning, £600; engineer stores, ballooning, £4,950; Aldershot balloon factory, £200. Total £5,750.

A NEW NAVIGABLE BALLOON.—Mr. Douglas Neale is engaged in designing a new form of navigable balloon, which he proposes to experiment with shortly at the Alexandra Palace. It is said that the motor will be a steam engine of 25 horse-power, weighing less

than half a ton, the fuel being oil, and that a screw propeller will be placed in front of the "bow" of the balloon. But the inventor, not unnaturally, does not wish to publish further details of his scheme in its present uncertain stage.

AN AEROPLANE PROPELLER.—An interesting test is reported as having been made on November 30th of an aeroplane propeller, designed by Professor Langley, on the Mount Holly, Lumberton, and Medford branch of the Pennsylvania Railroad. The car used was of the jumper pattern, and weighed, together with its equipment, 3,800 pounds. On the rear of the car were two wings, in the shape of propeller blades, each about 9ft. from tip to tip. The framework was of wood. It was covered with stout muslin. The power was furnished by a gasoline engine of 6-horse power, which caused the wings to rotate. The start was made from the Pennsylvania railroad freight depot in Mount Holly. Prof. Langley was accompanied by Mr. J. E. Watkins, of the Smithsonian Institution, assistant train-master Walter Antrim, assistant supervisor Wisman, of the Pennsylvania railway, and two machinists. When the engine was started, the car travelled slowly at first, on an up-grade, but as a level piece of track was reached better time was made. The machinery worked smoothly, and the wings made 400 revolutions per minute, which gave the car a speed of between 5 and 6 miles an hour. One section of the road, between Mount Holly and Lumberton, was traversed several times, the result being the same, or substantially so, each time. The amount of energy developed has not yet been figured out. It was stated that another trial will be made over the same road by Professor Langley in a day or two, on which occasion the size of the wings may be changed and the pitch altered.—*Machinery.*

THE BLUE HILL METEOROLOGICAL KITE OBSERVATIONS.—Regular bulletins are now issued, of which we have received two numbers, giving details of the ascents and facsimiles of the "Meteorograms," or registers of the instruments used.

EDDY'S "HOUSE" KITES.—Mr. W. A. Eddy sends us an account of his latest device in kites. These are shaped exactly like a small house with gable roof, the bridle being attached underneath the floor. Mr. Eddy says "the apex of the roof of the kite has great buoyancy which I am obliged to offset by decided convexities in the lower floor of the kite." They are constructed with a framework of light spruce sticks and a covering of paper, and are about three feet square.

SCIENTIFIC BALLOONING.—In order to test the accuracy of the formula of Laplace for deriving the altitude of a balloon, &c., from the barometric record, Cailletet, to whose ingenious apparatus for collecting air samples we referred in our articles on "Scientific Ballooning," has devised a photographic camera which has been constructed by Gaumont. A prismatic box is suspended from the balloon. Lenses are inserted in the lower and in the upper face. Between the two a band of sensitised celluloid is moved by a clockwork and exposed at regular intervals. The one lens produces an image of the scenery down below on the earth, the other of the needle of the barometer, whose point appears near the centre of the plate, which has a size of 13 by 18 centimetres (5 in. by 7 in.). From the distance on the plate between two prominent objects on the ground the height of the balloon can be derived. Satisfactory experiments having been made with this apparatus on the Eiffel Tower, Hermite and Besançon took it up with them on October 21 in their new balloon of 1,700 cubic metres capacity, a gift of the Russian scientist, Balaschof. The weather was tempestuous, and the balloon descended after a trip of four hours, having attained an altitude of 2,500 metres. The camera is said to have answered very well; 26 photographs were obtained. The apparatus is now to be secured against the influences of very low temperatures.

BALLOON AND TRAMCAR COLLIDE.—A rare and sensational mishap occurred some time ago on the Templehof field, Berlin. In the yard of the Military Aeronautic Department two balloons stood ready to be let loose. One was a "captive," and secured to its cable car, the other was being held down by soldiers. All at once a strong gust of wind seized the free balloon, wrenched it out of the soldiers' hands, and carried it off with lightning speed into the clouds. Almost at the same time the second balloon was caught away, and dragged the car at a tremendous speed out of the barrack yard and across the Templehof field. In crossing the high road it collided with a fearful crash with a tramcar, which was upset. It is wonderful that, although there were five passengers in the car, no one was injured. Two soldiers who

had been dragged some little distance by the balloon was slightly hurt. The other balloon was reported to have crossed the Russian frontier about noon.

BALLOON NET OF SPIDERS' WEB.—According to the *Temps* correspondent at Antananarivo, a special fine net made entirely of spiders' webs, is being manufactured in the professional school at Antananarivo. The process is a very simple one. The thread of several dozen spiders is wound on winders, the quantity produced by each spider ranging from 15 to 40 yards. The covering of the web is removed by repeated washing, and the web made into a thread of eight strands. When the thread is spun it is easily woven into a gauze which is very fine but very strong. It is to be used for an experimental covering of a navigable balloon by M. Renard, the head of the French military balloon school at Chalais, near Paris, who has been engaged for many years in experimenting in aerial navigation. It is believed that the difference in the weight of an ordinary covering and the spiders' web net will make a great improvement.—*Dalziel.*

Recent Publications.

Stories of Balloon Adventures (F. Mundell. London: Sunday School Union, 1s. 6d.), is merely a popular account of startling and adventurous balloon journeys, fancifully illustrated.

Exploration of the Air by Means of Kites is a new publication by the Blue Hill Meteorological Observatory. It is divided into three parts. The first on "Kites and Instruments," by S. P. Fergusson, gives a short historical sketch of the subject, followed by details of the construction of the kites used in the experiments, as well as the various instruments. Then follows a series of tables, giving the results from the Kite Meteorographs, while the third part consists of a discussion of the records by H. Helm Clayton. The work is carefully got up, with good illustrations and numerous diagrams, and is worth careful study by all kite flyers.

Andrée and his Balloons (Westminster: A. Constable & Co., 6s.), from the French of Henri Lachambre, who built the balloon, and A. Machuron, his assistant, who was present at the start. This book, giving a complete history of Andrée and the balloon in which he has ascended, is somewhat disappointing in several respects. It is fully illustrated by a number of good photographs, but many of them are of no special interest, and several good photographs have appeared elsewhere which might well have been included to make the book complete. The frontispiece is a rather fanciful coloured sketch, and no map is given. Another matter is unsatisfactory—newspaper reports at the time gave various versions of the pigeon message received from Andrée, and in this book two quite different versions are given at pages 10 and 306, and it is on this point that reliable information is required. A facsimile of the message is reproduced, which we suppose must settle the matter, the appended translation being "good journey eastwards, 10° south," but if this is so, why put in the words (on page 10) "good progress towards the north"? A good deal of the book is occupied with M. Lachambre's personal feelings and doings during his journey to Spitzbergen in 1896. On the whole, however, this is a most interesting and complete account of this unique and extraordinary Polar expedition, and should form a necessary addition to the library of every aeronaut.

Foreign Aeronautical Periodicals.

L'AERONAUTE (Paris), *January:* "Our Thirty-first Year," by W. de Fonvielle, recounting briefly what has happened since this journal was first started in 1868. "Three Ascents of the Balloon, 'Pégase.'" A letter from L. Godard with reference to the balloon journey of 24 hours.

February: "On the Minimum Effort Necessary to Sustain a Flying Apparatus." Note by Capt. Marcotti on Viscomte Decazes' paper. "Lessons to the Pupils of the French School of Aerial Navigation—Heat." Extracts translated from Major Moore's paper. A communication from Colonel Touche on "Calculations of the Resistance of the Air."

March: "Ascent of a Balloon of 750 Cubic Meters." New Method of Producing Hydrogen. Hofman's Aeroplane.

LA FRANCE AERIENNE (Paris), 1—15 *January:* "Study of the Means to Employ to Attain the Triumph of the Resistance of the Air." Long article by Jobert. "The Conquest of the Air by the Direction of Balloons."

1—15 *February:* "Aeronautics from Day to Day." "The Wind."

1—15 *March:* "Philosophy of Aerial Navigation," (continued), J. Corelli. "Wings! Wings!" by M. C. Du Pouey.

15—31 *March:* "An Aerial Voyage," by R. Bouchard (continued).

ILLUSTRIRTE AERONAUTISCHE MITTHEILUNGEN (Strassburg), *January:* "Leonhard Sohncke," life, with portrait. "American Gliding Experiments," O. Chanute (illustrated), in English and German. "Taking the Temperature at Heights." "The Equipment of the Balloon Section," by Lieut. Hinterstoisser, Commandant of the Military Aeronautical Establishment. "The Elongated Balloon and Experiments with the Aluminium Balloons in Berlin," (illustrated). "New Kite Experiments at the Blue Hill Observatory," A. L Rotch (in English). "The History of the International Balloon Ascents," by Dr. Hergesell. "The Mechanical Principle of Soaring Flight." "Opinions on the Design of Aerial Apparatus." Notes, &c.

ZEITSCHRIFT FUR LUFTSCHIFFAHRT. *February:* "On the Influence of Vertical Wind Currents on the Behaviour of Free Balloons," H. B. von Siegsfeld. "Flight—Particularly that of Birds and Insects," Mentz. "The History of the International Balloon Ascents," Prof. Assmann. Notes.

Notable Articles.

Jan. *Revue Scientifique* (Paris). — "The Schwarz Balloon;" "An Ascension of Twenty-four Hours."

11. *Machinery.*—"An Aeroplane Propeller." Prof. LANGLEY.

11. *English Mechanic.*—"The New Guidable Balloon, &c." E. WILSON.

21. *Engineer.*—"Soaring Birds." Major FULLERTON.

Feb. *Cassier's Magazine.* "A Balloon Railway."

Organ der Militär-wissenschaftlichen Vereine (Vienna).—"Ballooning in the Naval Service."

10. *Daily Chronicle.*—"Ballooning Across the Channel."

12. *Daily Chronicle.*—"New Flying Machine." Mr. Neil's dirigible balloon.

14. *New York Herald.*—"Eddy's New House Kites." (Illustrated.)

26. *Deutsche Heeres-Zeitung* (Berlin).—"The Influence of Ballooning in the Wars of the Future."

Mar. *McClure's Magazine.*—"Letters from the Andrée Party," and "Where is Andrée?" Two good articles, with numerous excellent and interesting illustrations from photographs.

Mar. 4. *Journal of the Society of Arts.*—"Kites: Their Theory and Practice." Capt. BADEN-POWELL. (Reprinted in this journal.)

10. *Morning Leader.* — "In Search of Andrée." (Illustrated.) Godard's new scheme.

16. *Cassell's Saturday Journal.*—"Shall we Ever be Able to Fly?"

Applications for Patents.

131. January 3. GRAF FERDINAND VON ZEPPELIN. **Improvements in and Relating to Navigable Balloons.**

304. January 5. THOMAS HAWKINS and FRANK S. D. SCOTT. **Improvements in or Relating to Aerial Ships or Vessels.**

557. January 8. WILLIAM CAIRD LINDSAY, Glasgow. **Fan Action Suitable for Aerial Locomotion, &c.**

2,986. February 5. L. W. BRONDWELL (A. WECZERA, Hungary). **Improvements in Flying Machines.**

3,515. February 12. LEONARD S. BLACKDEN, Cambridge. **Flying Machine Balancing Gear.**

3,922. February 16. NILS PEARSON THEANDER. **Improvements in Driving Chains and Chain Wheels for Flying Machines and other Driving Gear.**

4,257. February 21. DOUGLAS NEALE, Edinburgh. **Improvements in Navigable Balloons.**

4,258. February 21. DOUGLAS NEALE, Edinburgh. **Improvements in Machinery for Propelling and Steering Air Vessels.**

4,842. February 28. JAMES ST. CLAIR LEGGE, Dublin. **A New Motive Power for Motor Cars, Flying Machines, and the like.**

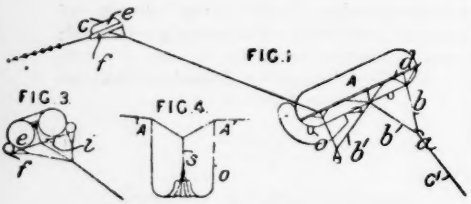
5,499. March 7. FREDERICK W. BENNETT, Penge. **An Improved Machine for Propelling a Balloon.**

7,214. March 25. CHARLES RITZINGER. **Improvement of a Parachute for Escaping from Fire and Accidents of Aeronautical Workers.**

Patent Published.

From the *Illustrated Official Journal.*

19,978. September 9, 1896. **Captive Balloons** RIEDINGER, A., Eisenhammerstrasse 23, Augsburg, Germany.



Relates to the invention described in Specification No. 18,773, A.D. 1895. To a girdle *d* is attached a robe *b*, which passes around a pulley *a* on the holding down rope C'; the ends of the rope *b* are secured at the windward end and near the middle of the length of the balloon A respectively; the car is supported by a similar rope *b*' attached to the middle and leeward end. The apparatus is steadied by a kite or aerostat C, comprising two annular buoyant chambers *e*, *f*, covered with a fabric which is kept distended by air entering through *i*. The ropes are attached as shown in Fig. 3, and the apparatus may be provided with a tail. Safety valves *o* on the balloon A comprise a sleeve O, Fig. 4, the end of which is turned in and secured by elastic cords S; an abnormal rise in pressure stretches the cords and opens the end of the sleeve.

United States Patents.

598,038. January 25. C S. WARDWELL, Stamford, Conn. **Foldable Kite.**

598,777. February 8. C. J. GREINER, St. Louis, Mo. **Multiplane Kite.**

French Patents.

(Class VI., 3.)

270,264. HERKENRATH. **Aerostat with Radiating Gas Chambers.**

271,505. DANILEVSKY. **System of Aerial Apparatus.**

271 512. VARICLE. **Means of Directing Balloons to Deviate from the Ae ial Current.**

271,948. ADER. **Dirigeable Balloon.**

272,572. KOCH. **Apparatus for Aviation, with Fixed Wings and Paddle Wheels.**

German Patents.

(Class 77.)

APPLICATIONS.

Z. 2,072. COUNT F. ZEPPELIN, Stuttgart. **Elongated Aerial Apparatus with Lifting Vessels Arranged One Behind Another.**

B. 19,051. Dr. R. BEENEN, Dresden. **Transposing Contrivance for Flying Apparatus.**

R. 10,842. Dr. H. RUDOLPH, St. Goars hausen. **Captive Balloon with Kite Plane.**